

**Fire Protection Assessment / Fire Hazard Analysis
Building 956, 957, 959, Booster Application Facility
Brookhaven National Laboratory**

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Purpose/Scope

The purpose of this assessment is to comprehensively and qualitatively assess the risk from fire within the Booster Application Facility (BAF) Complex to ensure DOE fire safety objectives are met. DOE fire protection criteria are outlined in DOE Order 420.1¹, Chapter 4. The fire protection assessment includes identifying the risks from fire and related hazards (direct flame impingement, hot gases, smoke migration, fire-fighting water damage, etc.). A Fire Hazard Analysis (FHA), required for the Safety Analysis Document for the BAF Complex, is incorporated into this assessment.

Summary

The planned use of the BAF Complex is described in the "Occupancy and Associated Fire Hazards", section below. These descriptions are based on field surveys, a review of the planned and completed installations, and discussions with BAF project staff. This assessment and FHA demonstrates the achievement of a reasonable and equivalent level of fire safety that meets DOE improved risk objectives.

Recommendations:

- 1) Propane gas cylinder storage should be located exterior to the building to minimize the risk to the occupants and experimental facilities.
- 2) The load management plan for the existing AGS emergency generators should be updated to ensure adequate electrical supplies are available for the BAF Complex's emergency load.
- 3) Backup of data collected as part of this program should be examined to ensure it is being adequately protected in accordance with DOE requirements.

¹US Department of Energy Order No. 420.1, Facility Safety, 11/16/95

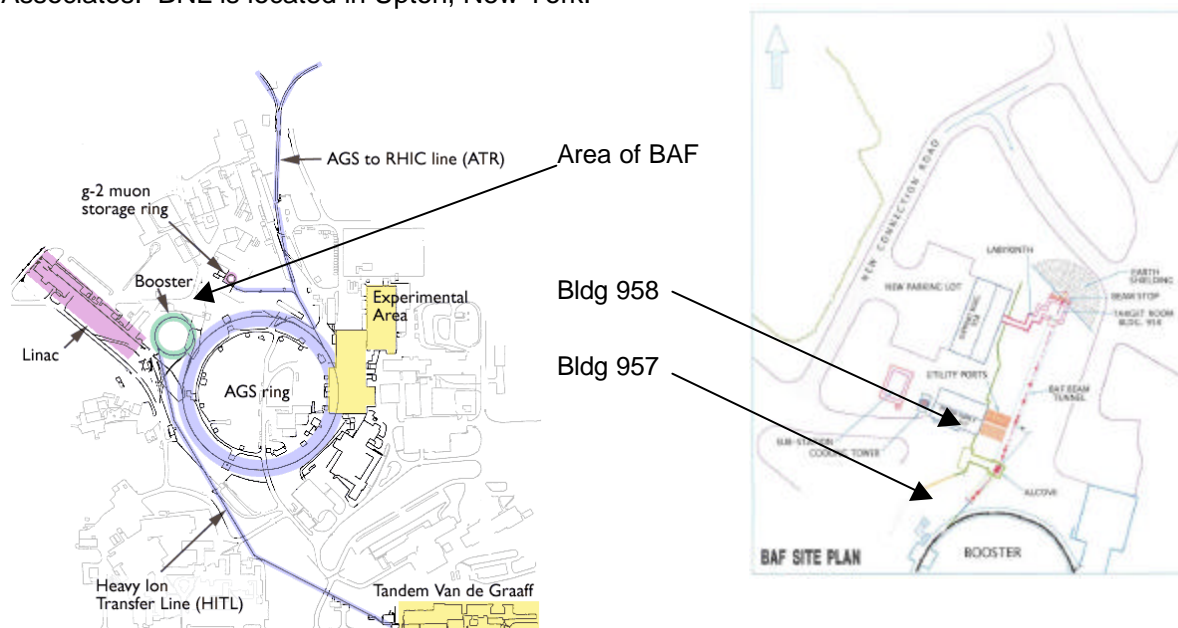
Analysis

0. Scope

The assessment and analysis of the BAF Complex is divided into three fire areas; the Target Room and Tunnel (Bldg. 956), the Power Supply Building (Bldg. 957), and the BAF Support Building (Bldg. 958). This assessment and FHA does not include any portion of the Booster or other AGS facilities. Physical features provide isolation with respect to fire propagation between the fire areas and from the Booster and other AGS facilities. This assessment and FHA are based on information supplied by the BAF project and on a review of construction drawings and specifications (Plant engineering Job Number 8976).

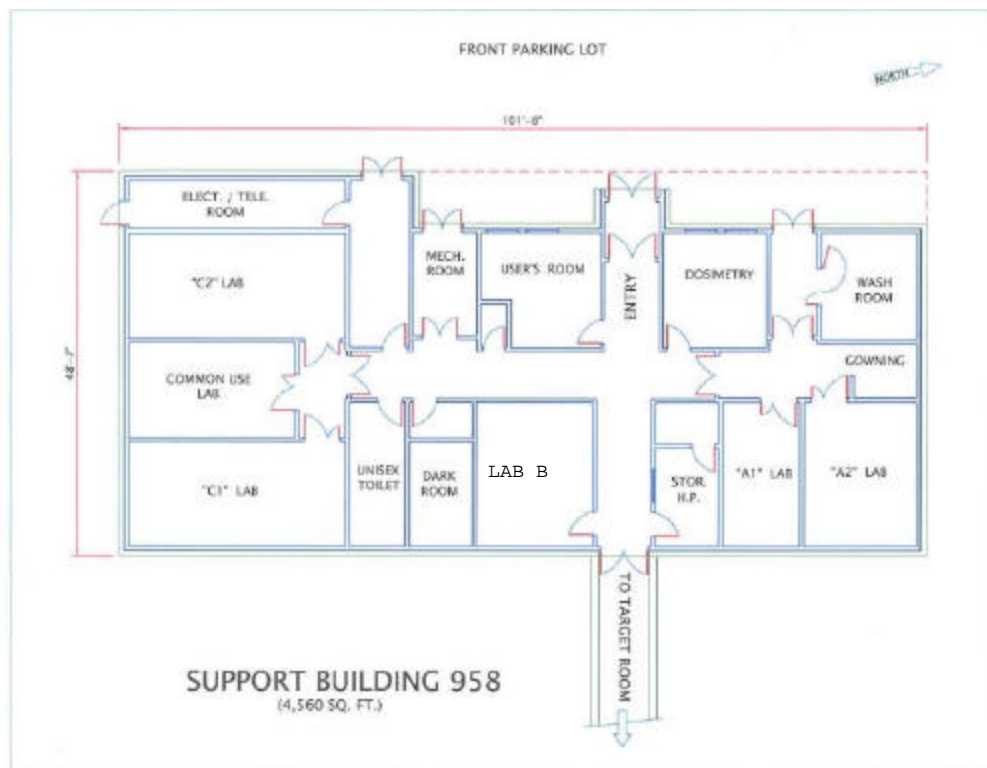
1. Construction

The BAF Complex is located in the northern region of Brookhaven National Laboratory (BNL). BNL is a 5,000 acre site owned by the Department of Energy and operated by Brookhaven Science Associates. BNL is located in Upton, New York.



Building 958 (BAF Support Building)

Currently under construction, the BAF Support Building is a one story high pre-engineered structure, with a floor dimensions of 100 ft. by 40 ft (interior dimensions). The building walls are masonry for the first few feet and then constructed of insulated metal panels on steel frames for the remaining height. The roof is a sloped insulated metal roof with fiberglass insulation added beneath. The walls and roof assemblies are considered to be equivalent to non-combustible construction. The foundation is poured concrete. Interior walls are gypsum board on steel stud. A non-combustible suspended ceiling is being provided. There are no interior fire barriers.



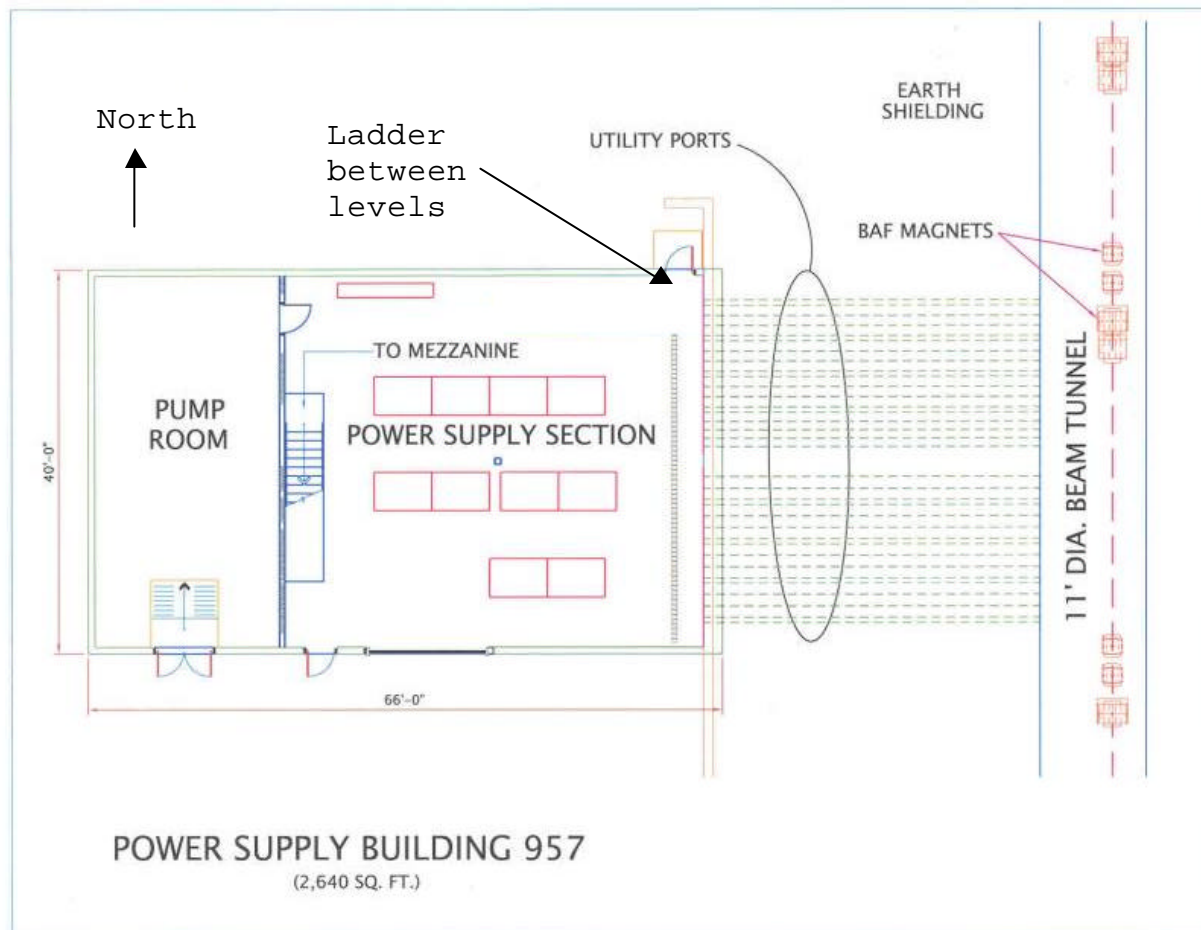
Building 956 (Target Room and Tunnel)

Currently under construction, the Target Room is a 20 ft. by 20 ft. by 10 ft. high (interior dimensions) poured concrete room. The flame spread rating of the finish is considered to meet ASTM E-84 Class A rating. The room is located underground and is connected to the BAF Support Building by a poured concrete labyrinth on the west side. The Target Room connects to the tunnel on the south side. The accelerator beam line enters through the tunnel opening. A radiation security gate and door separate the Target Room from the Tunnel. The structure is windowless and does not contain interior fire barriers.

The tunnel is constructed from a corrugated metal tube, 11 ft. in diameter. Concrete flooring will be provided. The flame spread rating of the finish is considered to meet ASTM E-84 Class A rating. The tunnel is located underneath approximately 15 ft. of earth (for radiation shielding). The structure is windowless and does not contain interior fire barriers.

Building 957 (Power Supply Building)

The Power Supply Building is currently under construction. The building is 65 ft. by 40 ft. (interior dimensions) with a concrete slab floor. The Power Supply Building is a two-story high building constructed of non-combustible pre-engineered insulated metal walls and roof. The second floor has been created by the installation of a metal mezzanine. A metal cooling tower is being installed to the west of the Power Supply Building.



An electrical substation is located to the west of Bldg. 957. The 1500 kVa and 2000 kVa electrical transformers and switch gear are arranged to meet the recommendations in Factory Mutual Loss Prevention Data Sheet 5-4 for fire protection. The transformers do not present an exposure hazard to the facility or each other.

1.1 Fire Barriers

There are no requirements for fire barriers for hazard separations. Facility values and loss potentials are well below the DOE \$50 million threshold for fire barriers.

The BAF is isolated from the AGS Booster by several feet of earth shielding. A metal vacuum beamline penetrates the shielding between the BAF and the AGS Booster. The area lacks combustibles and will not convey fire from the Booster to the BAF. While this arrangement is not a rated firewall assemble, it serves as physical isolation of the Booster (Bldg. 942) and the BAF complex.

1.2 Windstorm Damage Potential

The insulated metal deck roofs of Bldg. 957 and Bldg. 958 are designed to withstand local windstorms as per New York State Building Code. There are no windstorm concerns with the underground Target Room and Tunnel.

2. Occupancy and Associate Fire Hazards

The BAF project is intended to simulate radiation fields encountered in space that may cause deleterious effects in humans during prolonged space missions. The BAF Support Building will be used for cell and animal target preparation and assessment. The cell preparation laboratories will store and prepare cell cultures. Animal study rooms will house and prepare animals. Minimal flammable liquids will be used (1 quart quantities and less) in these laboratories. Toxic materials and infectious organisms will not be used. Due to the potential for biohazards being present in the building, the area will be considered a Biosafety Level II facility by National Institute of Health Standards (see below for more details).

2.1 Critical Process Equipment

The following table list the systems that will be present in the complex, their values (including development costs) and their expected replacement values (without salvage).

Location	System	Total Cost(\$k)	Estimated Replacement Cost(\$k) (material & labor, less engineering)
BAF Tunnel			
	Magnets	\$470	\$155
	Instrumentation	\$750	\$365
	Vacuum	\$645	\$305
	Target Room-Dosimetry	\$1,000	\$250
Experimental Support Bldg.			
	Dosimetry Room - Dosimetry	\$1,400	\$600
	Laboratories – Lab Equipment	\$278	\$206
Power Supply Bldg.			
	Power Supplies	\$850	\$550
	Instrumentation	\$750	\$200
	Vacuum	\$200	\$100
	Pump Room -Pumps & Heat Exchanger	\$420	\$100

2.2 Special Occupancies

Special occupancies include electronic data processing and vital/important records. The special occupancies of BAF are expanded upon in sections 2.2.1 and 2.2.2, below.

2.2.1 Electronic Data Processing

The Dosimetry Room, located in the Support Building, contains high valued electronics for measuring delivered dose to the target organisms. The Physics Lab (Lab B), also located in the Service Building, contains high valued electronics for data collection. Bldg. 958 is fully sprinklered and the Dosimetry Room and Physics Lab are provided with early warning smoke detectors. With early warning smoke detectors and the presence of facility sprinkler protection, the electronic data

processing areas are suitable for equipment values over \$25 million dollars. Total values of each area are under \$1 million dollars.

2.2.2 Vital and Important Records Storage

Vital records are those records which are essential to the mission of an important program and which, if lost, could not be reproduced or obtained elsewhere. Important records are those records possessing a high value to the mission of an important program but which, if lost, could be reproduced or reconstructed with difficulty or extra expense.

Based on the above definition, the data collected from the experiments are considered vital records. Backup of data collected as part of this program should be examined to ensure it is being adequately protected in accordance with DOE requirements (recommendation #3).

2.3 Unique Fire Hazards

Unique fire hazards include; trailers, cooling towers, flammable liquid and gas storage, cable trays, housekeeping in vital areas, and highly combustible building materials. The unique fire hazards at the BAF Complex are expanded upon in sections 2.3.1 through 2.3.6, below.

2.3.1 Trailers

No trailers are planned. However, if trailers are needed at a later date, their installation and use will follow BNL standards. BNL standards require compliance with the DOE Standard on Portable Structures.

2.3.2 Cooling Towers

The experimental system has a water-based heat removal system. One cooling tower is located to the west of Bldg. 957. The unit is metal, prefabricated, and serves the BAF magnet cooling water system, and the power supply/buss cooling system. A fire in the cooling tower will not cause damage to the main buildings due to spatial separation and the limited amount of combustibles in the tower.

2.3.3 Flammable Liquid & Gas Storage

The use of flammable liquids will be minimal. The anticipated use of solvents will be less than 1 quart in each laboratory space. Use of flammable liquids will follow BNL ES&H Standards (found at <https://sbms.bnl.gov/ld/ld08/ld08d481.pdf>).

The only use of a flammable gas will be for Bunsen burners in the lab spaces. Propane gas will be distributed through a fixed piping system. Current plans show the gas distribution supply located in the electrical mechanical room of the Support Building (recommendation #1). The use of all flammable gases will follow BNL Standards found at <https://sbms.bnl.gov/ld/ld08/ld08d491.pdf>.

2.3.4 Cable Trays

High voltage, low voltage, control, and signaling cables are to be segregated in accordance with NEC requirements throughout the BAF Complex. The cabling is located in conduits, raceways and cable trays. In most instances, the cables provided in the cable trays meet the flammability test criteria in IEEE 383, VW-1, and/or NEC rated wire for cable trays. These less flammable cables

decrease the overall fuel loading and loss potential in the tunnel, making the need for sprinkler protection in the tunnel unnecessary.

2.3.5 Housekeeping in Vital Areas

For this high value facility, good housekeeping and control of combustibles will be essential. The Collider-Accelerator Department self-inspection program will be extended to this complex.

2.3.6 Highly Combustible Building Materials

No significant amounts of exposed polystyrene insulation or other highly combustible building materials are used in the construction or operations at the BAF Complex.

3. Fire Protection/Suppression Features

3.1 Site Water System

BNL has a combination domestic and fire protection water supply system. The system is supplied by several deep wells and is stabilized by two elevated water storage tanks (one 1 million gallon and 350,000gallon capacity). The wells have electric primary drivers and a limited number have backup internal combustion drivers. The system can sustain three days of domestic supply and a maximum fire demand (4,000 gpm for 4 hours) for BNL with two of the system's largest pumps out and one storage tank unavailable. The piping distribution network is well gridded. The distribution system in the area of the BAF Complex has a static supply pressure of 68 psi. The piping system can supply 958 gpm at 51 psi residual pressure. This supply is adequate for the automatic sprinkler system in the Support Building

Fire hydrants are provided within 300 ft. of each facility. Frost proof hydrants are needed since the frost line extends to 4 feet below the surface in the winter. BNL and the local Suffolk County Fire Departments use National Standard Thread couplings.

BNL's Plant Engineering Division maintains the water supply system. BNL's Fire/Rescue Group conducts valve inspections on the distribution system to ensure reliability of firefighting water supplies.

3.2 BNL Fire/Rescue Group

The BNL Fire/Rescue Group is a full time, paid department. Minimum staffing is five firefighters and one officer per shift. The firefighters are trained to meet Firefighter Level III by International Fire Service Training Association standard, National Fire Protection Association (NFPA) Fire Fighter Level II standard, and (NFPA) Hazardous Material Technician Level and they are Suffolk County Certified Confined Space Rescuers.

The BNL Fire/Rescue Group also provides emergency medical services to an on-site population of 3200 people. A minimum of two members per shift hold New York State "Emergency Medical Technician - D" certifications ("D" is for defibrillation). Normally all five firefighters have EMT status. The Group operates a New York State Certified Basic Life Support ambulance (a 1988 Wheeled Coach Type I on a Type III Chassis). Medivac services are available to BNL via the Suffolk County Police Department (a training session).

Additionally the Fire/Rescue Group has two 1500 gpm. "Class A" Pumpers, one Rescue Vehicle for initial hazardous material incident response and heavy rescue operation, one Command Post Vehicle, one 5 ton military chassis converted to a Long Island Style Brush Truck.

The single Fire Station is located on the west side of the BNL Site. Response time to the most remote section of the BNL Site is less than eight minutes. Response time to the BAF Complex is estimated at 5 minutes.

BNL participates in the Suffolk County Mutual Aid Agreement. This allows the resources from over 130 departments to assist BNL. BNL is also a member of the Town of Brookhaven Foam Bank and Town of Brookhaven Hazardous Material Mutual Aid Agreement.

3.3 Site Fire Alarm System

Brookhaven National Laboratory provides central fire alarm station coverage by an Underwriter Laboratory listed multiplexed Site Fire Alarm System. The system is a Wormald System 1000, installed in 1987 (Wormald is now known as Grinnell Fire System). The system complies with the requirements of NFPA 72 for a Style 7D System.

The system uses the existing site telephone cable plant. RS232 signals are sent via full duplex line drivers. Each fire alarm panel has two channels connected to the Central Station. The panels are divided into 7 communication "loops." The system can monitor more than 20,000 points. It is currently monitoring 3,800. Response time from alarm at the panel to alarm indication at the Central Station is less than 10 seconds, which is well within the 90 seconds allowed by NFPA 72.

The main console is at the Firehouse, Bldg. 599. This station monitors all fire alarm signals, trouble and communication status alarms. A satellite station is provided at Safeguards and Security, Bldg. 50, and receives only the fire alarm signals. If the Firehouse does not acknowledge an alarm within 90 seconds, the satellite station at Bldg. 50 will receive an audible indication to handle the alarm. A second satellite station is provided at AGS Main Control Room, Bldg. 911, and receives only the fire alarm signals from the RHIC/AGS accelerator buildings. A team of operators and Health Physics Support personnel respond during accelerator operating times.

3.4 Fire Extinguishers

Fire extinguishers are being installed throughout the facilities in accordance with NFPA 10.

3.5 Target Room and Tunnel (Bldg. 956)

3.5.1 Fire Department Standpipe

The Tunnel is provided with one fire department hose connection adjacent to the labyrinth entrance from the Target Building. With the tunnel having two entrances (one at the Target Building, one at the Power Supply Building) and only being 250 feet long, additional coverage is not necessary.

3.5.2 Fire Detection and Suppression

The Target Room and Tunnel are provided with an automatic fire detection. Since there is limited combustible loading and the maximum possible fire loss potential of less than \$1 million dollars, automatic fire suppression is not warranted.

3.6 Power Supply Building (Bldg. 957) Fire Detection and Suppression

The Power Supply Building is provided with automatic fire detection. Smoke detection is provided in power supply areas. Areas with mechanical equipment are provided with heat detection. The facility is not provided with an automatic fire suppression system. The limited combustible loading and maximum possible fire loss potential of less than \$1 million dollars do not warrant a dedicated fire protection system for this building.

3.6 Support Building (Bldg. 958) Fire Detection and Suppression

The Support Building is provided with an automatic fire suppression system throughout the facility and early warning smoke detection system in areas containing high valued electronic equipment. The sprinkler system in the Support Building is designed to provide 0.15 gpm per square foot sprinkler density over 2500 sq. ft. of the most hydraulically remote area of the building while supplying 250 gpm for fire hose streams. The system requires 926 gpm at 43 psi.

4.1 Fire Protection of Vital Programs

The operations associated with this facility are not considered to be a DOE vital program. Therefore, no special fire protection precautions, beyond those that are generically described above, are required for this facility.

4.2 Fire Protection of High Value Property

The majority of the dollar value is concentrated in the Power Supply Building, the Target Room, and the Dosimetry Room. These areas are valued below \$25 Million and loss potentials are acceptable for these areas.

5.3 Protection of Essential Safety Class Systems

There are no essential safety class systems associated with this non-nuclear facility.

6. Fire Loss Potentials

Fire loss potentials are classified into two major categories; the maximum possible fire loss and the recovery potential. The loss potentials for the BAF Complex are expanded upon in sections 6.1 and 6.2, below.

6.1 Maximum Possible Fire Loss (MPFL)

The Maximum Possible Fire Loss (MPFL) for the BAF Complex is estimated separately for each of the three primary fire areas. The MPFL for the Tunnel and Target Building (Bldg. 956) is estimated to be less than \$250k (replacement costs). The MPFL for the Power Supply Building (Bldg. 957) is estimated to be less than \$750K (replacement costs). The MPFL for the Service Building (Bldg. 958) is conservatively estimated to be less than \$900k (replacement costs). Bldg. 958 is provided with automatic sprinkler protection as required by DOE for areas with an MPFL in excess of \$1 million.

6.2 Recovery Potential

7. Security Considerations Related to Fire Protection

The facility will have security measures to restrict access, including card readers and an iris scanner. Provisions will be made for Fire/Rescue access via card reader programming, provision of master key, or installation of interlocked crash doors. Radiation security barriers comply with the Life Safety Code for egress. Ingress will include interlocked crash panels in the doors to allow emergency entry.

7.1 Exposure Fire Potential

The BAF Complex is located in the northern part of BNL and borders the Pine Barrens wildlands. Established roadways provided engineered features that help protect the facility from a potential wildland fire. Pine trees and shrubs do not pose a potential exposure to the insulated metal structures. The roof systems will not ignite from burning brand produced in a brush fire.

The electrical substation to the west of Bldg. 957 does not pose a fire exposure to the complex, as previously described.

The cooling tower does not pose a fire exposure to the complex, as previously described.

No other facilities pose a fire exposure to the BAF Complex.

8. Environmental Impact due to a Fire (Including Water Runoff)

Toxic, biological, and radiation incidents resulting from a fire, including water runoff, are analyzed in sections 8.1 through 8.3, below.

8.1 Toxic Incident

There are no known materials in the BAF complex that, if involved in a fire, would result in a significant quantity of toxic material being created and released.

8.2 Biological Incident

While biological matter will be present in the laboratory spaces, the hazard is low. There are no aggressive organisms. The operations are being designed to meet the National Institute of Health Biosafety Level II since some biohazards may be present (typical hepatitis/HIV concerns). Other than pre-fire planning information, there are no fire issues related to blood borne pathogens.

8.3 Radiation Incident

By the nature of the operations of the accelerator, various pieces of equipment can become activated. This activation is not expected to pose a significant environmental impact in the event of a fire since the material will not be easily disbursed. Animals and cells that are part of the BAF experiments will not receive doses that will induce activation near levels of concern.

For calibration of instruments, several small sealed calibration sources will be present. These sources do not have the curie content or the physical state to be disbursed and contaminate large areas.

No other radioactive materials are used or stored in the BAF Complex.

9. Pre-fire and Emergency Planning

The BNL Fire Department maintains an adequate pre-fire plan book for this facility (<http://home.bnl.gov/emergencyservices/runcards/>).

A Local Emergency Plan is maintained for the BAF Complex. It includes CA Main Control Room actions to take with various alarms.

9.1 Fire Apparatus Accessibility

Fire apparatus accessibility is adequate for the main facility. Current parking lot configurations allow access by apparatus in the event of an emergency.

10. Life Safety Considerations

Major life safety considerations for this industrial facility include the following components; means of egress components and capacity, number and arrangement of the means of egress, travel distances to exits, discharge from the exits, and emergency lighting and marking of the means of egress.

The likelihood of a fast spreading fire is remote, given the nature of combustibles within the BAF facilities. Hence the facility is considered to be an ordinary hazard special purpose industrial

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occupancy. Emergency power is provided to the lighting throughout the facility. The emergency power source is an existing emergency generator at the AGS. The additional load should be included in the load management plan for the AGS generators to ensure adequacy of supplies (see Recommendation #2).

The anticipated occupancy load is less than 15 people in the Target Room and Tunnel. Two means of egress are provided. Both are conventional exits with radiation security gates that are crashable. The dead end created by the Tunnel at the connection to the AGS Booster Facility is within limits for an unsprinklered industrial occupancy.

Smoke removal ventilation is provided in the Tunnel. One 17,000 cfm exhaust fan is located at the tunnel's mid point. Two make-up airshafts are supplied by the exit points. Activation will be by manual stations at the fire alarm control panel and the labyrinth entrance to the tunnel. While smoke removal is not required by code, it is essential for fighting a fire in a windowless, underground facility.

Bldg. 958 (Support Building) is considered an industrial space with a typical occupancy under 25 people. Two remote exits are provided from the common corridor. The facility complies with the requirements of the Life Safety Code for an ordinary hazard occupancy without a significant use of flammable liquids. Laboratory spaces using significant quantities of flammable liquids would require a second means of egress from the space as opposed to the current single exit paths to the corridors. Flammable liquid usage will be controlled and monitored by the FUA and the departmental inspection program.

Bldg. 957 (Power Supply Building) is considered a special purpose industrial space with a typical occupancy load of under 10 people. The occupancy load of the mezzanine area is not expected to exceed three persons. The second floor mezzanine uses a ladder as a secondary means of egress to the ground floor as allowed by the Life Safety Code for boiler rooms and similar spaces subject to occupancy not to exceed three persons who are capable of using the ladder. The means of egress for Building 957 comply with the requirements of the Life Safety Code.